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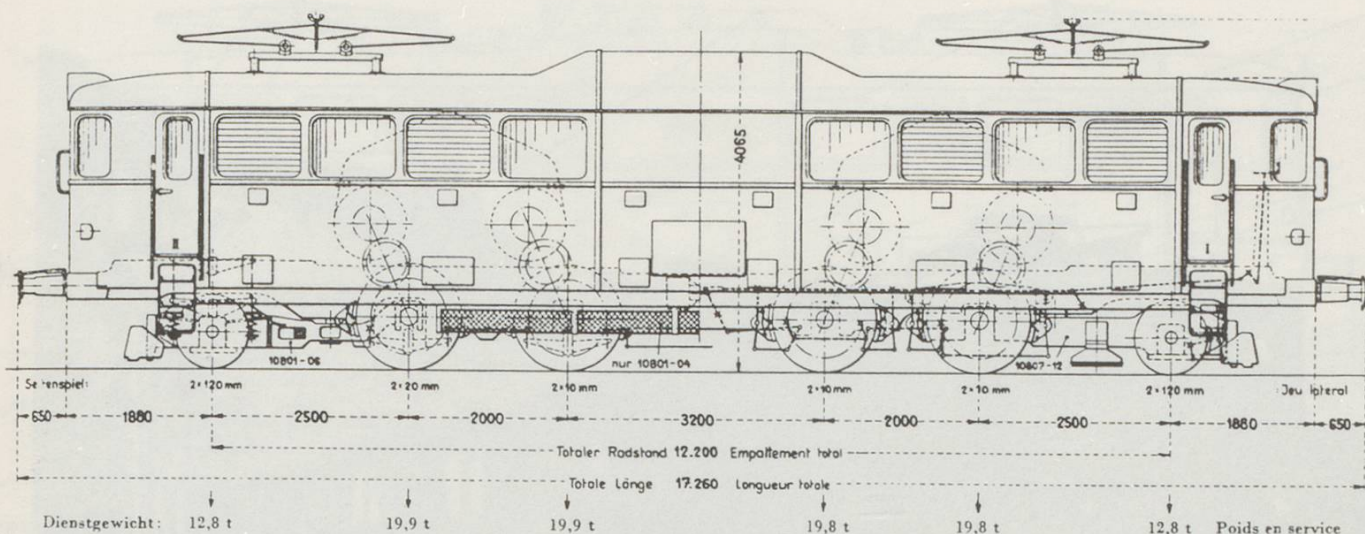
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The Gotthard Trams

The SBB Ae4/6 Nos.10801-10812

by John Jesson



The more modern SBB locomotive classes, Ae6/6, Re4/4 and Re6/6 will be familiar to most members, as well as the older Ae3/6' and Ae4/7. Perhaps less familiar, but nevertheless still to be seen are the examples of classes preserved in running order, which were listed in the SBB handbook *Kursbuch für Eisenbahnfreunde*, (now discontinued). The Ae4/6 however has disappeared completely from the scene, the last two of the class being withdrawn at the timetable change in May 1983, none being preserved. This article will try to throw a little light onto this relatively unknown class, its development, service and problems.

The large tractive effort of the Ae8/14 locomotives, 11801 and 11851 (built 1931 and 1932) could only be utilised on freight trains over the mountain sections of the Gotthard and Monte Ceneri lines. Through working of passenger trains by the class was found to be uneconomical because the high power was only occasionally of use. It was decided therefore to use the design of the 12000 HP Ae8/14 No.11852, but to divide it into two separate locomotives which could be used individually or in multiple.

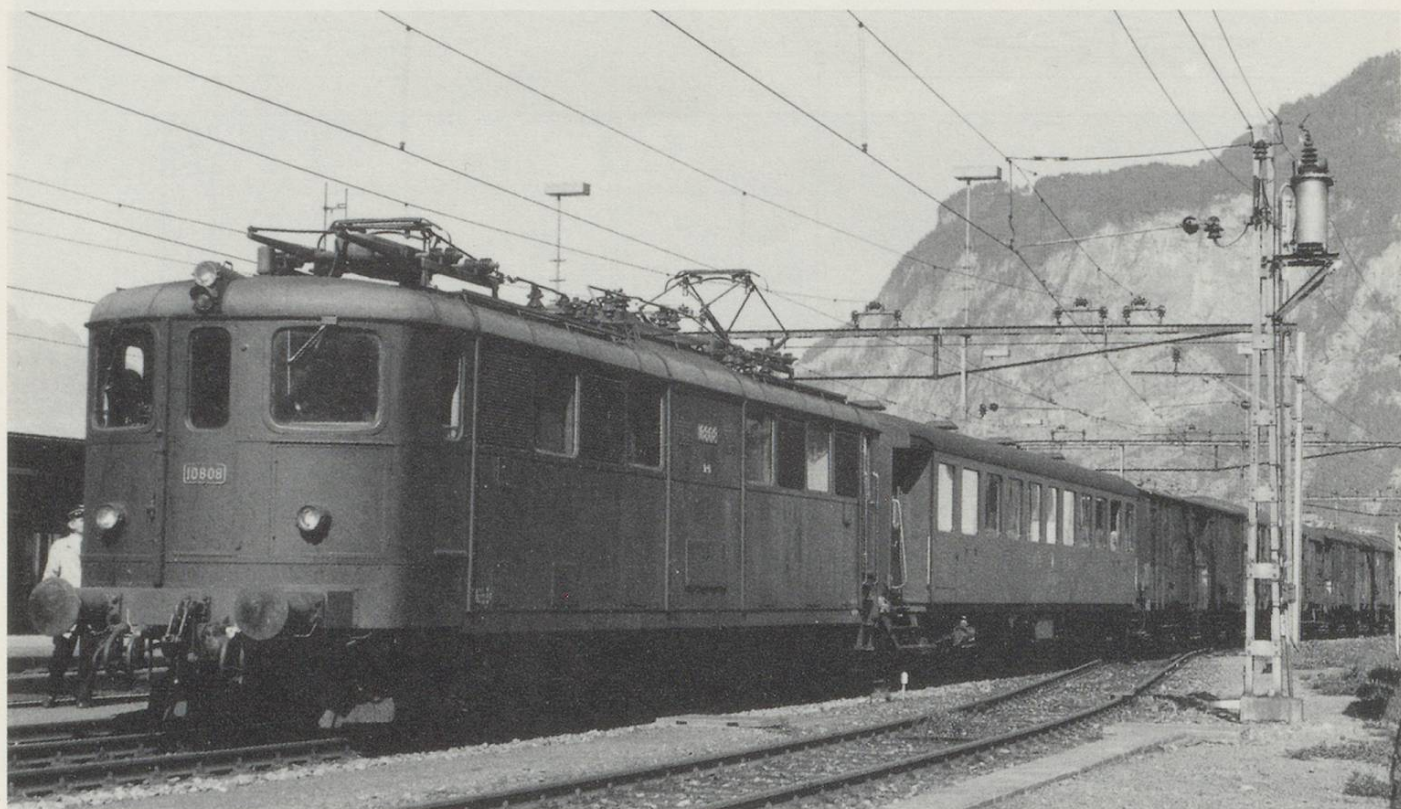
Orders were placed in 1939/40 for four locomotives, the remaining eight being ordered at a later date. It was found possible to omit the middle carrying axle because of substantial

weight savings, principally of the traction motors and regenerative braking equipment. The mechanical components were made by SLM (Schweizerische Lokomotiv und Maschinenfabrik, Winterthur) whilst electrical equipment was supplied by BBC (Brown Boveri Co., Baden), MFO (Maschinenfabrik, Oerlikon) and SAAS (SA des Ateliers de Secheron, Geneve).

Specifications laid down included the ability for a single locomotive to haul a 375 tonne train at 75 km/h on a 2.6% gradient, and for two locomotives to haul 770 tonnes under similar conditions. On gradients of up to 1%, with a load of 800 tonnes a speed of 90 km/h was required. The maximum speed was to be 125 km/h and all units were to be fitted with regenerative brakes and multiple control.

On the first six locomotives, Nos.10801-10806, Java trucks were used for the carrying axles at each end, but Nos.10807-10812 were fitted with combined pony/driving axle bogies, which contributed to the locomotive being better guided into curves and diverging turnouts.

The SLM universal drive with double reduction gearing was used, but between 1961 and 1968 was replaced on locomotives Nos.10807-10812 with a special form of the BBC spring drive, giving a slight alteration to the



Ae4/6 No. 10808 on Guterzug at Flüelen on 8 October 1979

Photo Alan Pike

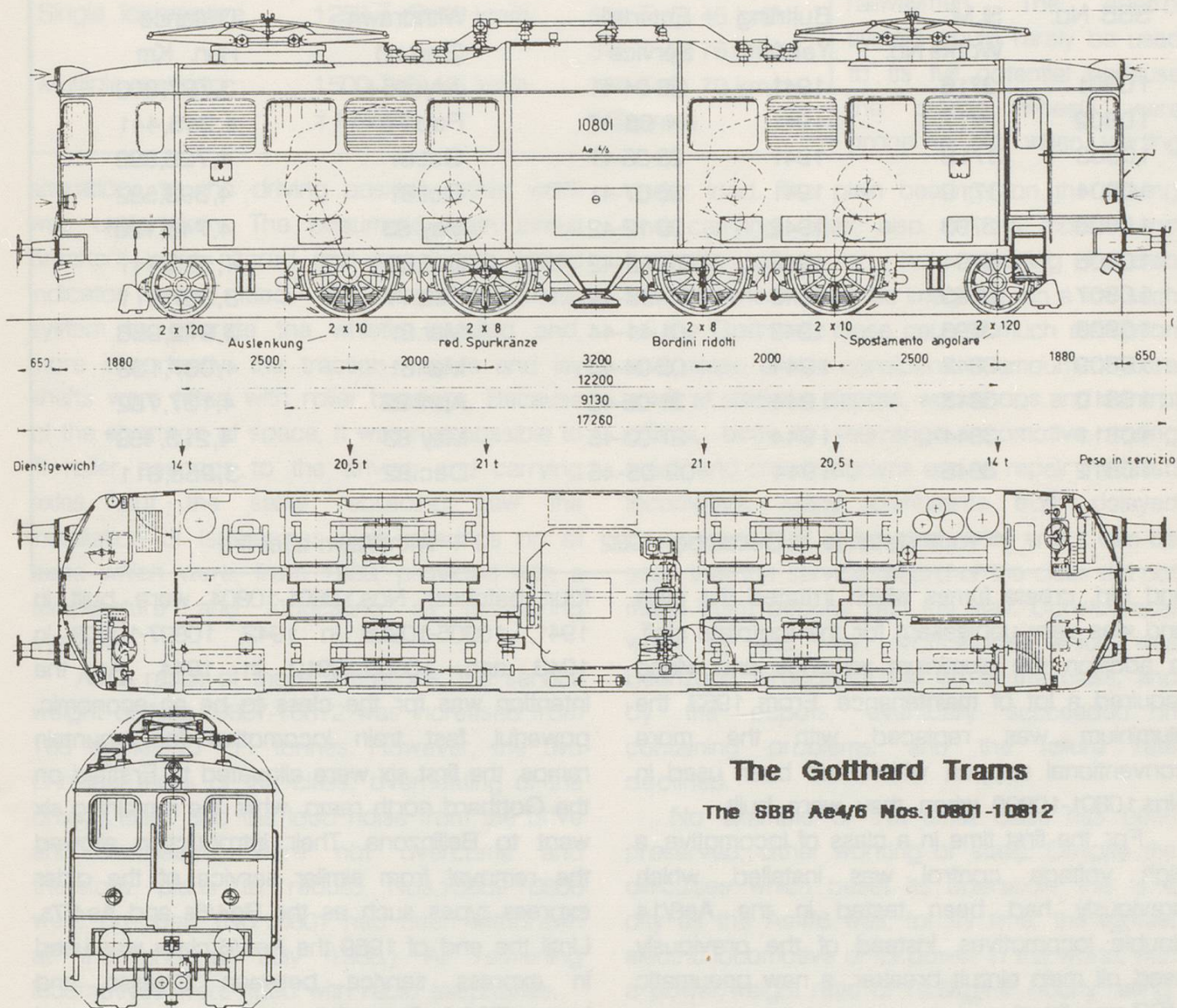
original gear ratio of 1:3.22 to 1:3.19. Both drive systems were very noisy when under load, with a loud howling from the ventilators. Frequently, conversation in the driving cab became impossible as it was not possible to distinguish separate words. Railwaymen gave the Ae4/6 the nicknames *Gotthard Tram* and *Air Howler*. Because of the failure of the BBC drive to overcome the problem, Nos.10801-10806 retained the original drive.

The bodies of the locomotives were of lightweight construction, with extensive use being made of aluminium. The driving position for standing operation was on the left hand side. Previously only railcars were so equipped, locomotives being right hand drive; henceforth all new locomotives were to conform to the left hand standard. Nos.10807-10812 were rebuilt for seated operation in the period 1961-1966, following the format of the Ae6/6 Nos.11403-11520.

The Knorr driver's brake valve, previously

tested on the Ae4/7 Nos.10952 and 10983, was installed, the first time an entire SBB class had been so equipped. From 1956 onwards they were replaced by the Oerlikon FV4 type valve. The normal Westinghouse brake had three positions for freight, passenger and light engine operation. Supplementary equipment prevented simultaneous action of compressed air and regenerative brakes. When the regenerative brakes were in operation, the six motors of groups 2 to 4 acted as generators and one motor of group 1 acted as an exciter for the other six motors, whilst the remaining motor idled.

Construction of the locomotives faced severe difficulties as World War II had led to a world-wide shortage of raw materials. One emergency measure resorted to was the use of aluminium for the transformer and traction motor windings and some other wiring in the last six locomotives, Nos.10807-10812. This was not an unqualified success, as overheating could,



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Table 1 Specification of SBB Ae4/6

	Original	Rebuilt
Driving wheel diameter	1350 mm	1350 mm
Carrying wheel diameter	950 mm	950 mm
Service weight	105.0 T	111.0 T
Adhesive weight	79.4 T	83.0 T
Number of motors	8	8
Gear ratio	1:3.22	1:3.19
Maximum tractive effort	28,000 kg	22,200 kg
Hourly T/E at 85 km/h	17,600 kg	17,600 kg
Continuous T/E	16,400 kg	16,400 kg
Hourly output	5,540 HP	5,540 HP
Continuous output	5,230 HP	5,230 HP
Maximum speed	125 km/h	125 km/h
Electric brake	Regenerative	

Table 2 SBB Ae4/6 Class History

SBB No.	SLM Works No.	Building Year	Entered Service	Withdrawn (End of)	Distance Run. Km
10801	3716	1941	26-04-41	July 65+	3,797,800
10802	3717	1941	14-06-41	Feb.77	4,345,441
10803	3718	1941	26-05-41	Oct.81	4,725,896
10804	3719	1941	26-07-41	Oct.81	4,393,532
10805	3793	1942	09-12-42	May 83	4,746,120*
10806	3794	1942	31-12-42	Oct.82	4,525,441
10807	3795	1943	31-08-44	Feb.77	3,327,911
10808	3796	1943	01-11-44	Mar.81	3,912,956
10809	3842	1944	05-04-45	Mar.81	4,087,138
10810	3843	1944	31-05-45	April 82	4,137,782
10811	3844	1944	27-03-45	May 83	4,213,458*
10812	3845	1944	02-05-45	Dec.82	3,953,811

* Total distance at December 1982 + Withdrawn after fire

and did, create fumes which irritated the eyes and was very unpleasant for the footplate staff. In addition the aluminium windings and wiring required a lot of maintenance. From 1953, the aluminium was replaced with the more conventional copper, which had been used in Nos.10801-10806 when they were built.

For the first time in a class of locomotive, a high voltage control was installed, which previously had been tested in the Ae8/14 double locomotives. Instead of the previously used oil main circuit breaker, a new pneumatic MCB was fitted.

Multiple controls were fitted, using two 26-way jumper cables, but this was later removed and locomotives had to be individually manned. From 1961-1966, however, the class was again fitted with multiple control, this time using the MFO system used for push-pull trains. However well it worked on the push-pull trains, it did not always work as it should in the Ae4/6s, and it was possible for two locomotives, supposedly coupled in multiple, to pull away in opposite directions. There was in Erstfeld depot a list of which cabs on which locomotives could be coupled together and it was, at times, necessary to turn a locomotive to avoid problems.

The twelve locomotives were delivered in

four batches; Nos.10801-10804 were built in 1941, 10805-10806 in 1942, 10807-10808 in 1943 and 10809-10812 in 1944. As the intention was for the class to be an economic, powerful, fast train locomotive for mountain ramps, the first six were allocated to Erstfeld on the Gotthard north ramp, while the remaining six went to Bellinzona. Their introduction allowed the removal from similar service of the older express types such as the Be4/6s and Ae4/7s. Until the end of 1959 the Ae4/6 class was used in express service between Chiasso and Luzern/Zürich. From then on they were replaced by the newer Ae6/6s, and were used for piloting and assistance duties on both the Gotthard and Mount Ceneri ramps and also on fast trains between Luzern and Basel. After the mid-seventies, although the piloting of freight trains remained in their duty rosters, their usage was now more on pick-up and light freight, parcels and local passenger trains. Their operational area still extended from Luzern over the Gotthard to Bellinzona and on to Locarno. The whole service life of the class was on the Gotthard and its approach lines.

As already mentioned, in the period 1961-1966, Nos.10807-10812 were given a major rebuild. Apart from the replacement of the SLM universal drive with a BBC spring drive and the

Table 3 Trailing Loadings for SBB Ae4/6

	1% gradient	2.6% gradient
Single locomotive	1250 T @ 80 km/h	520 T @ 45 km/h† 375 T @ 75 km/h†
Multiple working	1500 T @ 95 km/h ‡ Freight	770 T @ 70 km/h ¶ Express

alterations to the driving position, other work was undertaken. The pneumatic main circuit breakers were altered and an electric speed indicator was fitted, an electro-pneumatic system to operate the whistle installed and, more importantly, the traction motors and lay shafts were fitted with roller bearings. Because of the shortage of space, it was not possible to fit roller bearings to the driving and carrying axles, but the same rebuilding saw the installation of Isothermos plain bearings on all axles which were, from 1968, provided with a temperature and lubricating oil monitoring system.

As a result of these alterations, the service weight of Nos.10807-10812 was increased from 105 tonnes to 111 tonnes. However, the two principal faults of the class; overheating of the driving axles and the loud noise from the drive and ventilators, were not overcome and therefore plans to rebuild Nos.10802-10806 were dropped (No.10801 had been withdrawn at the end of July 1986.) All remaining locomotives were fitted with radio telephones.

The maximum speed of 125 km/h was never of real use, the normal maximum being 110 km/h. From the beginning of the seventies the maximum speed was set at 100 km/h.

On 10 July 1965, No.10801 was completely burnt out at Maroggia-Melano, between Lugano and Mendrisio. The flames reached to a height of five metres, and the aluminium parts of the locomotive melted as a result of the great heat. As it was no longer in a fit state to be moved, No.10801 had to be cut up on site and removed on freight wagons. It was the first example of the class to be withdrawn and was used for spare parts. The fire had started in electrical resistors mounted over the driving wheels. These resistances were moved to another location on the remainder of the class.

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The Ae4/6 was an unpopular class with the railwaymen. The control system could rarely be used to its full potential because the driving wheels were prone to slip when starting

under load. The plain bearings on the driving and carrying axles, also on the motors and lay shafts, often ran hot, resulting in train breakdowns. As can be imagined, on a line such as the Gotthard, these caused much disruption and delay, and a considerable amount of extra work at stations, depots, workshops and control offices, both to rearrange locomotive, rolling stock and crew diagrams and to repair the failed locomotive. Many complaints from delayed passengers had to be dealt with, and it can be seen that the service record of the class did not make them popular with the staff. Considerable work by the main workshops, which was Bellinzona throughout the life of the class, and by the depots, eventually succeeded in containing problems, and the failure rate declined.

No example of this small class has been preserved, either working or static. Despite the difficulties which beset its operation, this is a pity as the Ae4/6 was, for its time, the lightest electric locomotive of its power in the world, with a power/weight ratio of 19.6kg/HP hourly rating. The construction of the locomotive during the war was a considerable achievement for the Swiss electrical and machine industries and the class was another step forward in the 80 year history of electric traction in Switzerland.

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